DOCUMENT RESUME

ED 128 065	95	PS 008 706

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TITLE	Conceptual Rule Acquisition and Retention by Young Children: The Effects of Modeling, Age, and Corrective Feedback.
INSTITUTION	Arizona Univ., Tucson. Arizona Center for Educational Research and Development.
SPONS AGENCY	National Coordination Center for Early Childhood Education, St. Ann, Mo.; National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	Mar 73
NOTE	28p.
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	Age Differences; *Cognitive Development; *Concept Teaching; Day Care Programs; Early Childhood Education; *Feedback; Generalization; *Imitation; *Observational Learning; *Preschool Children; Research; Retention; Teaching Methods; Teaching Techniques

ABSTRACT

The effects of modeling and corrective feedback on conceptual rule acquisition and retention were studied with a total of 48 3- and 4-year-old children. Equal numbers of children from each age group were randomly assigned to one of four training groups: modeling, corrective feedback, modeling and corrective feedback, and a no modeling/no corrective feedback control condition. Children were tested for generalization immediately after training, and for retention seven to ten days later. Brief observation of a model was effective in creating significant acquisition and retention of conceptual rule judgments and explanations. Corrective feedback improved the child's ability to explain the conceptual rule but did not assist nonverbal performance. The facilitative influence of corrective feedback was largely confined to the 4-year-old age group. In general, 4-year-old children were more successful than 3-year-olds in learning to provide viable reasons for conceptual judgments. The pedagogical significance of these findings is discussed. (Author/SB)

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CONCEPTUAL RULE ACQUISITION AND RETENTION BY YOUNG CHILDREN: THE EFFECTS OF MODELING, AGE, AND CORRECTIVE FEEDBACK

by

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March, 1973

Abstract

The effects of modeling and corrective feedback on conceptual rule acquisition and retention was studied with three- and four-year-old children. Brief observation of a model was effective in creating significant acquisition and retention of conceptual rule judgments and explanations. Corrective feedback improved the child's ability to explain the conceptual rule but did not assist nonverbal performance. The facilitative influence of corrective feedback was largely confined to the four-year-old age group. In general, four year-old children were more successful than three-year-olds in learning to provide viable reasons for conceptual judgments. The pedagogical significance of these findings are discussed.

CONCEPTUAL RULE ACQUISITION AND RETENTION
BY YOUNG CHILDREN: THE EFFECTS OF
MODELING, AGE, AND CORRECTIVE FEEDBACK[1]

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Recent research in the social learning tradition has focused on vicarious acquisition of rule-governed responses. Modeling procedures have proven effective in teaching children from a wide range of age groups and socioeconomic-ethnic backgrounds a variety of linguistic and conceptual skills. For example, with regard to language rules, children have been taught appropriate use of plural morphemes (Guess, Sailor, Rutherford, & Baer; 1968), prepositional phrase use (Bandura & Harris, 1966), verb tense and sentence kernal structure (Carroll, Rosenthal, & Brysch, 1972), and sentence complexity and length (Harris & Hassemer, 1972).

Another group of studies have centered on the acquisition and generalization of conceptual rules. For example, observational learning procedures have been found effective in conveying simple clustering rules (Rosenthal, Alford & Rasp, 1972), relational rules (Zimmerman & Rosenthal, 1972b, 1972b), abstract categories for question formulation (Rosenthal, Zimmerman, & Durning, 1970), and even rules for generating creative responses (Zimmerman, & Dialessi, in press). In all of the above studies, the child induced the superordinate rule governing the model's behavior by observing the model perform according to the rule on a variety of instructional task items. The child then had the opportunity to imitate the model on the same task and finally on an altered generalization task.

One topic of interest that grew out of this observational learning research on concept formation involved vicarious rule learning by young children. Rosenthal & Zimmerman (1972) have found that modeling procedures were effective in teaching young children to conserve on Piagetian tasks. In one of a series of studies, children as young as four years of age were taught to conserve through observation of a model. In another study, six-year-old Mexican-American children were able to learn to conserve if exposed to adult's demonstration; children who were trained through a didactic verbal explanation procedure (without demonstration) failed to acquire the conceptual skill. Presumably, this differential result occurred because of the impoverished English language repertoires of these initially Spanish-speaking children. The effectiveness of these relatively brief training procedures in promoting concept formation with young children, suggested that modeling procedures might hold some potential as an instructional procedure for young children. The present study attempts to investigate further the effectiveness of observational learning procedures in teaching a different type of conceptual rule, that of class inclusion-exclusion or the "same-different" distinction. This new rule was selected to establish the generalizability of previously obtained results to a new instance of conceptual rule learning.

Previous research investigations of the "same-different" concept have focused on training only one of these complementary rule elements in isolation from the other. For example, the concept "same" has often been taught through the use of a match-to-standard design (e.g., Taylor & Wales, 1970). The concept of "difference" has been studied on oddity discrimination tasks (Brown, 1970; Small, 1970; Witte & Meek, 1970). In most of these studies, the stimuli to be grouped are presented without verbal directions and the child must induce the governing rule, or learn it, or both from the feedback accruing from his choices. This experimental limitation makes it difficult to generalize these results to most teaching situations and standardized test performance where children are expected to respond on the basis of explicit verbal directions. Further, little attention in previous research has been devoted towards teaching the child to verbalize the rules underlying his choice behavior or assessing a child's reasoning for his choice behavior. The present study will investigate the amenability to training of children's "same" and "different" conceptual behavior when the directions for responding are explicit. Further, attention will be directed at teaching verbal reasoning skills as well as nonverbal judgment responses to determine the relationship between these measures and how this relationship influences acquisition, transfer, and retention.

In research conducted with older children, feedback has been found effective in promoting conceptual and linguistic rule learning. Zimmerman and Pike (1972) reported that contingent praise statements significantly improved acquisition of question-asking skills with disadvantaged second graders. Zimmerman and Rosenthal (1972b) found that feedback significantly improved acquisition of a complex relational rule by fifth grade youngsters. Beilin (1965) reported that verbal rule provision (involving a restatement of the conceptual rule as well as knowledge of results) was effective in teaching kindergarten (presumably five-year-olds) to conserve. It is of interest to determine the relative effectiveness of this primarily verbal instructional procedure (herein termed corrective feedback) in teaching a different type of conceptual rule to even younger children whose language skills are more limited. Therefore, the present study will compare developmentally the relative effectiveness of modeling and corrective feedback procedures in promoting concept acquisition, generalization, and retention with three- and four-year-old children.

METHOD

Subjects and Experimenters

From four day care centers in Tucson, Arizona, 12 boys and 12 girls three years of age and a like number of four-year-olds were drawn and randomly assigned to each factorial combination of treatments. These day care centers served a middle- and lower-class Anglo-American population. The younger group ranged in age from 3.0 to 3.9 years, with a mean age of 3.4 years. The older group ranged from 4.0 to 4.8 years with a mean age of 4.2 years. A female graduate student served as the model, and another female graduate student acted as experimenter. Both adults were Anglo-Americans in their twenties, with no striking departures from average characteristics.

Task Materials

Three sets of stimulus cards were prepared. These cards were made of white card board and measured 12.5 cm by 20 cm. On each card, three sticker pictures were mounted in a triangular formation. Beneath the top picture (the standard) a blank line was drawn horizontally across the card. The two lower pictures were presented, evenly spaced, on the same horizontal plane. One picture was identical to the top "standard" picture, the other was different. Pictures were randomly assigned within the constraints of counterbalancing to a right or left position on the card. The identical lower picture (response pictures) appeared an equal number of times in each position. A description of the content of these stimulus cards is presented in Table 1.

Insert Table 1 about here

Set I stimuli, which were used for baseline and retention, was composed of eight cards. The stimuli on these cards were identical or dissimilar on the basis of four stimulus dimensions: object identity, size, color or pattern. There were thus two cards for each dimension. For example, with object identity, the standard on one card was a bird, and the response item was a bird and a horse; or with object pattern, the standard was a checkered triangle and the response items were a plain and checkered triangle. Each card was presented twice in succession and the child was asked to select the picture that was "same" or "different from" the standard. The order of asking for the same or different picture was randomized for each card with the constraint of having each type of question appear with equal frequency in each serial position. There were thus 16 items in Set I.

Set II stimuli, which were used for training, was composed of six different cards which were otherwise constructed and presented identically to those in Set I. These cards varied in only three dimensions: object identity, size, and pattern. Each card was presented twice in succession as described with regard to Set I stimuli or there were 12 different stimulus items. During training each stimulus item was presented twice, producing 24 training trials.

Set III stimuli, which were used to assess generalization, was constructed parallel with Set I stimuli. This set was comprised of eight different stimulus cards which varied in the same four stimulus dimensions as Set I: object identity, color, size, and texture. Each card was presented twice in succession according to the same counterbalancing constraints mentioned with regard to Set I cards. There were thus 16 generalization items.

Procedure and Design

Baseline and training phases. The child was taken individually from the class to a test room by the experimenter, introduced to the model and was directed by the experimenter as follows: "We're going to play a game with some picture cards. The picture up here (pointing to standard) is only for me to point to you. You can point to either this picture or this picture down here" (pointing to response pictures).

If the child appeared to be confused, the experimenter gave the child practice pointing to each picture. The experimenter began baseline by saying "point to the picture that is just the same as this" (pointing to standard). After the child responded nonverbally by pointing, the experimenter asked "Why?" Pilot testing revealed this single question to be most informative and least confusing to children of this age. The card was then removed and then reintroduced as follows, "Point to the picture that is different from this" (pointing to standard). After the child responded nonverbally, he was asked "Why?" This same questioning format was followed throughout baseline, generalization and retention testing.

The children were randomly assigned to one of four training groups: modeling, corrective feedback, modeling and corrective feedback, and a no modeling, no corrective feedback control condition. Equal numbers of male and female three-year-olds and four-year-olds were assigned to each training group.

Subjects assigned to the modeling condition were instructed as follows: "Now (the model) is going to play the game with us. Watch what she points to and listen to what she says. Point to the same thing she points to and say what she says. The model was then presented the first card. On "same" items the model replied "this is the same" (Why?) "because they are both flowers." With "different" items, the model responded "this is different" (Why?) "because it is a hat and a hat is different from flowers." As soon as the model finished responding, the card was removed from view and reintroduced for the child to respond to.

This model-then-observer alternation format was followed on the remaining training trials.

Children assigned to the corrective feedgack group were instructed as follows, "Now we are going to play the same game once more." The first card from Set II was then introduced. "If the child responded correctly, he was told "yes, that's right." If he responded incorrectly on a "same" question, he was told "no, this one is the same (pointing to correct picture), see it's a flower just like the one at the top. If the child responded incorrectly on a "different" question, he was told "no, this one is different (pointing to correct picture). It's a hat and a hat is different from flowers at the top."

Children assigned to the modeling and corrective feedback group were introduced to the task according to the modeling instructions presented above. After the child had the opportunity to imitate following model's performance, he was given corrective feedback also as described above.

Children assigned to the no model, no corrective feedback control group were simply tested with Set II stimuli.

Generalization phase. Immediately after training a generalization test was administered to assess both acquisition and transfer of the conceptual rule. The experimenter introduced the generalization task to children assigned to the modeling group as follows: "We are going to play the game some more. This time you will play by yourself. Keep on playing the game as good as you can." With subjects assigned to the corrective feedback condition, the directions were slightly altered

"We are going to play the game some more. <u>This time I can't tell you if you are right or wrong.</u> Keep on playing the game as good as you can." Children assigned to the modeling and corrective feedback condition received a combination of modeling and feedback directions (with redundant sentences presented only once). Control group youngsters received the same directions as the feedback group with the exception that the italicized sentence was deleted. After generalization phase testing, the children were told that the experimenter and model would return to play the game again. The subjects were thanked and returned to class.

<u>Retention phase.</u> After a seven to ten day delay, the experimenter and model returned and administered the baseline task as a measure of retention. The experimenter introduced the task as follows: "Now we are going to play the game again. We want to see how well you remember it. Keep on playing it the same way you learned it." Upon completion of retention phase testing, the child was thanked and returned to class.

<u>Scoring.</u> The children's responses to each stimulus card were scored as the number of correct nonverbal pointing responses (the <u>judgment</u> measure) and also the number of correct explanations (the <u>reasons</u> measure) for picture similarity or differences. For example, if the pictures were identical in color, explanations such as "they're both the same color" or "they're both red" would be scored as correct. Any explanation which was logically accurate was scored as correct even if the child offered a more generic label such as "men" for "elves". In actual practice there

was little difficulty in scoring each child's response; during pilot testing, independent coders displayed practically perfect agreement on a sample of subjects. In any phase a child's score was the number of the 16 items answered correctly for verbal and for nonverbal measures separately. While the judgments and reasons response measures were potentially independent, in no cases did a child give a correct reason without first displaying a correct judgment response.

RESULTS[2]

A 2 x 2 x 2 x 2 multivariate analysis of variance model (Morrison, 1967) was used to assess the effects of child age, child sex, modeling, and corrective feedback upon the response vector composed of child verbal and nonverbal conceptual responses at baseline, generalization, and retention phases. The dependent measure means for each treatment group are presented in Table 2.

Insert Table 2 about here

Between Groups Analysis

Corrective feedback significantly enhanced concept learning in general (see Table 3). Univariate F tests also presented in Table 3

Insert Table 3 about here

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revealed that feedback was effective in promoting concept formation according to both judgments and reasons response measures. Standardized discriminant function coefficients yielded by the overall multivariate test of feedback main effect indicate that the judgments measure accounted for the major part (65%) of this between groups difference.

A significant modeling main effect was noted on the response vector. However, modeling procedures improved concept formation only on the basis of the reasons measure. The age of the children also created a significant multivariate main effect. Older youngsters outperformed their younger counterparts in both judgments and reasoning. The differential influence of age was most evident on the judgments measure, a variable which accounted for almost 70% of the between groups differences (see standardized weights for this effect in Table 3).

Several higher order interactions achieved significance. A significant feedback X modeling interaction was noted. The multivariate interaction was created by a highly significant univariate interaction of modeling and feedback on the reasons response measure. Scheffe tests (Kirk, 1968) revealed that the mean ($M = .49$) of the no model, no feedback control group was significantly ($p < .05$) lower than that of the model, no feedback group ($M = 6.88$), the feedback, no model group ($M = 5.94$), and the model plus feedback group ($M = 6.25$). The latter three groups failed to differ among themselves. It thus appeared that both modeling and feedback enhanced concept acquisition, however the training effects did not combine additively.

There was a significant interaction between age and feedback as well. Univariate F tests revealed that this multivariate interaction was produced by differences in children's reasoning. Post hoc Scheffe tests disclosed that four-year-old children ($M = 9.18$) who received feedback evinced significantly ($p < .05$) more concept generalization than four-year-olds not receiving corrective feedback ($M = 3.97$) or three-year-olds who either did ($M = 3.52$) or did not ($M = 3.86$) receive feedback. It appears that the effectiveness of feedback was largely confined to the older, four-year-old children.

There was a marginally significant three way interaction between a child's sex, his age, and his exposure to modeling treatment. This multivariate effect was created by the judgments response measure.

No other interactions were statistically significant. The correlation between judgments and reasons measures of concept formation (across all groups) was $r = .44$, ($p < .005$) which indicated a moderate amount of dependence between both measures.

Within Phase Analysis

As a more sensitive measure of training effects, the effects of each independent variable were compared across baseline, generalization, and retention phases. In order to effect a multivariate analysis of these across phase differences in response, two change scores were computed for both judgments and reasons measures of conceptual response: the difference between baseline and generalization phases (the generalization effect) and the difference between baseline and retention phases (the retention effect). This multivariate analogue of the univariate repeated measures design is predicated upon the fact that two separate one degree of freedom comparisons can be made given two degrees of freedom deriving from three experimental phases. Accordingly the same overall 2 x 2 x 2 x 2 MANOVA was applied to a four variable vector array comprised of four difference scores: the generalization and retention effects for the judgments and for the reasons measures of conceptual response. The results of this within phase analysis are presented in Table 4.

Insert Table 4 about here

It should be noted that by directly converting the raw data to difference scores, this obviates the need for and indeed the possibility of determining an overall multivariate phase effect. The corresponding univariate overall phase effect is computed on the basis of differences between the mean of each phase; in the multivariate case, the means are already converted to difference scores thereby precluding such an analysis from being carried out. However, the determination of an overall trials effect is of little importance in interpreting the results of this study (or indeed in most studies employing a split-plot design) since primary interest is centered on the interactions of treatment groups and training phases.

There was a significant multivariate interaction between feedback and phases. Univariate $\underline{F}$ tests revealed that feedback significantly improved generalization and retention on only the reasons measure of conceptual response. Conceptual judgments were not influenced by feedback. Standardized discriminant function weights revealed that the generalization phase effect accounted for the major part of the between groups differences created by the multivariate feedback effect. However, the small weight assigned to the retention phase is probably due to the high correlation (r = .75) between the reasons generalization and retention effects. While both variables undoubtedly contributed substantially to distinguishing between age groups, the retention effect added little to what was already differentiated by the generalization effect since this latter variable occurred first in the discriminant function equation.

The modeling treatment significantly interacted with training phase. Modeling training significantly improved performance at generalization and retention phases according to both judgments and reasons response indices. This multivariate interaction effect was created by practically identical changes in both judgments and reasons response measures (see discriminant function weights). However, of the measures of improvement in reasoning, the generalization effect contributed most heavily (43% compared to 8%) to the multivariate interaction effect. As discussed above, the low discriminant function coefficient assigned to the retention effect was probably due to the high correlation between the generalization and retention effect.

The age X phases interaction also attained significance. Univariate F tests suggested that the age of the child significantly influenced his generalization and retention on only reasons measures of conceptual responding. Apparently age did not qualify or influence his learning of concept judgments. The standardized weights suggested that age primarily influenced the acquisition and generalization of reasoning responses (accounting for 47% of differences created by age X phase interaction) and not retention phase response. Again the low weight assigned to the retention phase response is probably created by the high correlation between the reasons generalization and retention effects.

There was a marginally significant four way interaction between phases, sex of child, feedback, and modeling factors. Univariate F tests revealed that this effect was largely confined to differential conceptual judgments performance at retention. No other interactions attained statistical significance.

DISCUSSION

To our knowledge, this is the first evidence of vicarious conceptual rule learning and retention by very young children. It was a particularly interesting experience because of the pronounced developmental differences that were encountered and the resulting difficulties these differences created with regard to developing a feasible experimental procedure. Numerous alterations in procedures were made during pilot testing in order to enhance experimental control and at the same time tailor the procedures to fit the needs of these youngsters. However, some difficulties persisted during the study itself. Sudden attenuations in motivation and attention were evident particularly with the three-year-old children who often would abruptly alter their responding in ideosyncratic fashion. In addition, considerable variability in speed of learning was noted during the study, even among like-aged children, making a fixed number of training trials experimental design less optimal than perhaps a trials-to-criterion design. The net effect of the difficulties in this initial study was to decrease the absolute magnitude of training groups' differences as may be noted in Table 2. Nonetheless, sufficient experimental control was present to establish the relative effectiveness of the training procedures studied in producing acquisition, generalization, and retention of the conceptual rule by both three- and four-year-old youngsters.

The significant corrective feedback effect on the judgments measures of concept formation that was revealed by the between groups analysis and not by the more sensitive within phase analysis deserves comment. As can be determined from Table 2, slight differences in baseline responding were noted in judgments between the feedback and nonfeedback groups. The corrective feedback groups had a slightly higher baseline than the nonfeedback group on the judgments measures; this slight baseline difference increased the mean response averaged across all phases (between groups effect) but at the same time decreased the amount of differences between baseline and subsequent experimental phases. Hence, the within phase analysis is most accurate in that baseline differences are adjusted in determining the overall effects. In this regard, the effectiveness of feedback was found to be limited to reasons measures of concept acquisition and retention, which is not suprising given the verbal character of corrective feedback. It was encouraging that modeling procedures, which involved overt demonstration as well as verbal description, were effective in promoting generalization and retention on both judgments and reasons measures of conceptual response.

The effects of a child's age played a complex, yet intriguing role in influencing concept acquisition and retention. From the between groups analyses, it was found that age influenced both judgments and reasons measures of conceptual responding. However, the multivariate sex effect produced by this analysis included baseline differences that existed between age groups. The within phase analysis which was based on change scores revealed that a child's age only influenced his learning to verbalize the concept taught; it did not qualify his nonverbal acquisition of the concept. It was also of interest to note (on the basis of the feedback X age interaction) that the corrective feedback instructional procedure was largely limited to four-year-old children. Since modeling procedures were effective in promoting both nonverbal and verbal acquisition and retention of the concept with both three- and four-year-old children, it would appear to hold some promise as an instructional method for training young children. However, more research on the age X treatment interaction is needed to establish the magnitude of these training effects across age groups on a variety of conceptual rule tasks before any conclusive recommendations can be made.

References

Bandura, A., & Harris, M.B. Modification of syntactic style. *Journal of Experimental Child Psychology*, 1966, *4*, 341-353.

Brown, A. L. Transfer performance in children's oddity learning as a function of dimension preferences, shift paradigm, and overtraining. *Journal of Experimental Child Psychology*, 1970, *9*, 307-319.

Carroll, W. R., Rosenthal, T. L., & Brysch, C. G. The social transmission of grammatical parameters. *Journal of Educational Psychology*, 1972, *63*, 589-596.

Guess, D., Sailor, W., Rutherford, G., & Baer, D.M. An experimental analysis of linguistic development: The productive use of the plural morpheme. *Journal of Applied Behavior Analysis*, 1968, *1*, 297-306.

Harris, M. B., & Hassemer, W. G. Some factors affecting the complexity of children's sentences: The effects of modeling, age, sex, and bilingualism. *Journal of Experimental Child Psychology*, 1972, *13*, 447-455.

Morrison, D. F. *Multivariate Statistical Methods.* New York: McGraw-Hill, 1967.

Kirk, R. E. *Experimental Design: Procedures for the Behavioral Sciences* Belmont, Calif.: Brooks/Cole, 1968.

Rosenthal, T. L., Alford, G. S., & Rasp, L. M. Concept attainment, generalization, and retention through observation and verbal coding. *Journal of Experimental Child Psychology*, 1972, *13*, 183-194.

Rosenthal, T. L., & Zimmerman, B. J. Modeling by exemplification and instruction in training conservation. Developmental Psychology, 1972 6, 392-401.

Rosenthal, T. L., Zimmerman, B. J., & Durning, K. Observationally induced changes in children's interrogative classes. Journal of Personality and Social Psychology, 1970, 15, 681-688.

Small, M. Y. Children's performance on an oddity problem as a function of the number of values on the relevant dimension. Journal of Experimental Child Psychology, 1970, 9, 336-341.

Taylor, J. A., & Wales, R. J. A developmental study of form discrimination in preschool children. Quarterly Journal of Experimental Psychology, 1970, 22, 720-734.

Witte, K. L., & Meek, V. C. The effects of concept training on preschool children's oddity performance. Psychonomic Science, 1970, 20, 94-95.

Zimmerman, B. J., & Dialessi, F. Modeling influences on children's creative behavior. Journal of Educational Psychology, in press.

Zimmerman, B. J., & Pike, E. O. Effects of modeling and reinforcement on the acquisition and generalization of question-asking behavior. Child Development, 1972, 43, 892-907.

Zimmerman, B. J., & Rosenthal, T. L. Concept attainment, transfer, and retention through observation and rule-provision. Journal of Experimental Child Psychology, 1972, 14, 139-150. (a).

Zimmerman, B. J., & Rosenthal, T. L. Observation, repetition, and ethnic background in concept attainment and generalization. Child Development, 1972, 43, 605-613. (b)

Footnotes

1. This study was prepared under the auspices of CEMREL, Inc., a private nonprofit corporation supported in part as an educational laboratory by funds from the National Institute of Education, Department of Health, Education, and Welfare. The opinions expressed in this publication do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement should be inferred. Valuable assistance was provided by the Arizona Center for Educational Research and Development. We wish to acknowledge the generous cooperation of the Directors and teachers of Emmanuel Baptist, Happy Trails, Little Bear, Catalina United Methodist Day Care centers in Tucson- Arizona. We wish to thank Pauline Miller and Susan Paquet for their assistance with aspects of this research.

2. All significance levels reported are based on 2-tailed probability estimates.

Table 1

Content Description of Stimulus Cards

Cards by Phase	Stimuli		
	dimensions	standard and "same" pictures	"different" picture
Baseline and retention			
1	object	elf	rocket
2	object	bird	house
3	color	blue triangle	brown triangle
4	color	green circle	orange circle
5	size	big clover	little clover
6	size	little flower	big flower
7	pattern	checkered triangle	plain triangle
8	pattern	striped rectangle	plain rectangle
Training:			
1	object	flower	hat
2	object	snowman	pinecone
3	size	little star	big star
4	size	big square	little square
5	pattern	plain rectangle	striped triangle
6	pattern	checkered rectangle	plain rectangle
Generalization:			
1	object	flower	harp
2	object	butterfly	cat
3	color	green squares	red square
4	color	blue cars	yellow car
5	size	little circles	big circle
6	size	big turkeys	little turkey
7	pattern	plain circles	star patterned circle
8	pattern	plain circles	dotted circle

Table 2

Main Treatment Variations by Phase for Each Dependent Measure

Groups	Dependent Measures					
	Judgments			Reasons		
	Baseline Phase	General-ization phase	Retention Phase	Baseline Phase	General-ization Phase	Retention Phase
Training: Combined Subjects						
all modeling	10.38	12.54	12.96	.79	9.46	9.46
all nonmodeling	10.25	10.96	10.25	.34	5.08	4.24
all feedback	10.75	12.58	12.34	.34	9.21	8.75
all nonfeedback	9.88	10.92	10.88	.79	5.34	4.94
Training: Separate Cells						
modeling, no feedback	10.17	12.75	12.42	1.40	9.67	9.58
feedback, no modeling	10.92	12.83	11.17	.50	9.16	8.17
modeling and feedback	10.58	12.33	13.50	.17	9.25	9.33
control	9.58	9.08	9.33	.17	1.00	.30
Age level:						
three-year-olds	9.66	10.04	10.30	.58	5.25	5.08
four-year-olds	10.96	13.46	12.88	.34	9.29	8.58
Sex:						
boys	9.83	11.25	10.46	.58	6.71	6.38
girls	10.79	12.25	12.70	.54	7.81	7.29

Table 3

Multivariate and Univariate Analyses of Between Groups Data

Effect	Tests of Statistical Significance										
	Multivariate Test			Univariate test of judgments response and discriminant function weights				Univariate test of reasons response and discriminant function weights			
	F^a	df	p<	F	df	p<	wts	F	df	p<	wts
S (Sex)	2.12	2/31	NS	4.36	1/32	.045	- .96	1.12	1/32	NS	- .08
F (Feedback)	6.19	2/31	.005	11.12	1/32	.002	.75	6.94	1/32	.013	.40
M (Modeling)	5.52	2/31	.009	2.35	1/32	NS	.02	11.40	1/32	.002	.99
A (Age)	9.81	2/31	.001	18.29	1/32	.001	- .80	9.92	1/32	.004	- .35
S x F	.03	2/31	NS	.02	1/32	NS	.17	.06	1/32	NS	.92
S x M	.20	2/31	NS	.19	1/32	NS	.30	.39	1/32	NS	.83
S x A	.41	2/31	NS	.07	1/32	NS	- .20	.82	1/32	NS	1.07
F x M	4.45	2/31	.02[illegible]	.82	1/32	NS	- .17	8.98	1/32	.005	1.06
F x A	7.16	2/31	.003	.68	1/32	NS	- .70	9.03	1/32	.005	1.09
M x A	.98	2/31	NS	1.84	1/32	NS	-1.10	.04	1/32	NS	.35
S x F x M	2.58	2/31	.092	5.33	1/32	.028	- .99	1.16	1/32	NS	- .03
S x F x A	1.89	2/31	NS	3.38	1/32	.075	-1.11	.03	1/32	NS	.41
S x M x A	2.99	2/31	.065	4.58	1/32	.04	-1.11	.03	1/32	NS	.57
F x M x A	.28	2/31	NS	.34	1/32	NS	-1.08	.03	1/32	NS	.72
S x F x M x A	2.40	2/31	NS	4.23	1/32	.048	-1.11	.02	1/32	NS	.43

[a] All multivariate tests of significance are based on Wilk's Lambda criterion.

Table 4

Multivariate and Univariate Analyses of Within Phase Data

Effect	Tests of Statistican Significance																
	Multivariate Test		Univariate test of generalization effect for judgments response			Univariate tests of retention effect for judgments response			Univariate test of generalization effect for reasons response			Univariate test of retention effect for reasons response		
	F^a	p<	F	p<	wts	F	p<	wts	F	p<	wts	F	p<	wts
P (Phase) x S (Sex)	.34	NS[b]	.55	NS	.20	.59	NS	.38	.72	NS	.22	1.12	NS	.56
P x F (Feedback)	3.02	.034	.06	NS	-.38	2.51	NS	.58	9.96	.003	.94	5.92	.021	- .06
P x M (Modeling)	3.02	.034	5.83	.002	.32	4.83	.035	.37	8.14	.008	.61	7.71	.009	.12
P x A (Age)	2.74	.048	4.92	.034	.39	2.20	NS	.15	8.84	.006	.63	8.03	.008	.13
P x S x F	1.36	NS	1.52	NS	-.98	1.38	NS	.95	.45	NS	-.27	.10	NS	.15
P x S x M	2.09	NS	0.00	NS	-.31	.13	NS	-.03	.37	NS	-.90	5.38	.027	1.54
P x S x A	1.51	NS	.02	NS	0.00	.76	NS	-.61	.02	NS	-1.12	1.66	NS	1.49
P x F x M	1.68	NS	1.52	NS	.27	.58	NS	.15	6.50	.016	1.11	3.05	.09	- .31
P x F x A	1.86	NS	.00	NS	-.18	.07	NS	-.08	7.80	.009	.94	4.37	.045	.10
P x M x A	.37	NS	.55	NS	-.98	.07	NS	.52	.09	NS	-.78	.04	NS	.93
P x S x F x M	2.37	.076	.66	NS	.42	4.83	.035	-1.06	.62	NS	-.38	1.31	NS	.82
P x S x F x A	.31	NS	.41	NS	-.49	.58	NS	-.58	.30	NS	.08	.30	NS	.70
P x S x M x A	.28	NS	.70	NS	-.59	.32	NS	-.03	0.00	NS	.87	.36	NS	-1.00
P x F x M x A	1.77	NS	.20	NS	.42	1.38	NS	-.83	.36	NS	-1.15	.00	NS	1.20
P x S x F x M x A	.55	NS	1.07	NS	1.05	.21	NS	-.88	.03	NS	-.26	.14	NS	.31

[a]All multivariate tests of significance are based on Wilk's Lambda criterion, with 4/29 df

[b]NS stands for norsignificant